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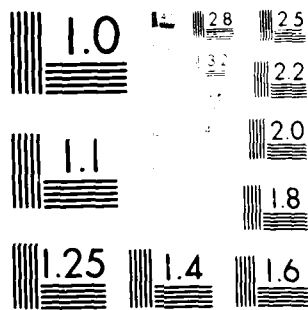
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THE DISPLACEMENT OF LOCAL SPENDING FOR POLLUTION CONTROL BY FEDERAL CONSTRUCTION GRANTS

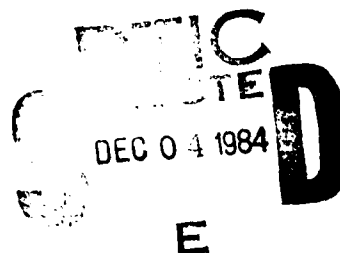
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The Public Research Institute

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The Displacement of Local Spending for Pollution Control by Federal Construction Grants

By JAMES JONDROW AND ROBERT A. LIVY*

It is well known that expenditure by the federal government can displace expenditure by private citizens and by state and local governments. Among the possible mechanisms for displacement, one is particularly direct: federal expenditures provide services to recipients that replace, to some extent, what the recipients would have purchased on their own. Food stamps, for example, increase the income of recipients, but not necessarily their food purchases; a substantial part of the aid simply might pay for food the recipient would have bought on his own. The same kind of displacement can occur when the federal government provides grants-in-aid to a state or local government for spending on particular items. If displacement is large, the federal role could be reduced without greatly affecting the total expenditure on those items.

In this paper we measure the extent to which state and local government spending on sewer system construction is displaced by EPA construction grants. The Construction Grants Program provides federal funds to local governments for the construction of sewer lines and sewage treatment plants. (This is a big program, as much as \$3-\$4 billion in recent years.) The federal role is often justified by referring to the externalities in pollution control: water pollution generated in one place moves downstream and may affect other communities (perhaps in another state). The federal Construction Grants Program was instituted to reduce water pollution by subsidizing the construction of large waste water treatment plants. Though the program provided matching

grants for the construction of plants, there were always some funds that were devoted to sewer lines as well.

If pollution is external to the community and state and local governments are not concerned with pollution flowing downstream, then federal expenditures should add to funds spent by local governments and generate little displacement. On the other hand, if federal funds substitute for local funds, perhaps because local governments were already doing something about the problem or because they were able to use the funds in ways to suit their own purposes, then substantial displacement should result.

We consider two kinds of displacement resulting from the grant program: permanent and temporary. Permanent displacement is created by the substitution of grants (after they are authorized by the federal government) for local expenditures that would have served the same purpose.

Temporary displacement is due to postponed spending by state or local governments primarily at the beginning of the program. There are two forms of temporary displacement. First, there are the delays built into the cranking up of any new program and inherent in the process of obtaining grants and meeting procedural requirements for spending them. Second, there is the waiting to see if one's project can get funding. A local politician cannot afford to start a project without federal aid when there is even a suspicion that funding could have been obtained.

I. The Model

We begin with the demand for sewer system structures financed by state and local funds. Note that the demand is in terms of a stock (structures) not a flow (new construction), since it is the entire stock that gen-

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erates services. This stock (S) is created using the perpetual inventory method and includes both sewer lines and treatment plants. The demand for S (denoted by S^*) is directly related to the stock of housing (H):

$$(1) \quad S^* = \alpha H^\beta,$$

where β measures the elasticity of S with respect to H .

Equation (1) represents demand in the absence of federal outlays, so that all of S^* is built with the community's own funds. We now generalize the definition of S^* to recognize that demand can be satisfied by structures built with grants as well as those built with the community's own funds. However, we include in S^* only the fraction (γ) of the stock of structures built with grants that serves the same function as the stock built with municipal funds.¹ This fraction can be interpreted as a measure of the "value" the community places on the stock of sewer structures built with federal funds. The fraction will approach unity when the value of the project is high so that federal expenditure displaces most of what the community would have built on its own. Similarly, when γ approaches 0, federal expenditure causes no displacement of local spending. If γ is strictly greater than 0 and less than 1, the remaining fraction ($1 - \gamma$) of the stock built with grants represents structures that the community would not have built, perhaps because the facility is of a different type or in a different location from one that the community would have chosen.

We define as the "effective" stock those structures built with the community's own funds (M) plus the share (γ) of the stock of structures built with grants (G) that provides service to the community. The desired effective stock is

$$(2) \quad S^* = (M + \gamma G)^* = \alpha H^\beta.$$

¹An alternative would be to adjust the price of sewer system construction to represent the federal share. This alternative, however, would only be appropriate if the community's entire demand for sewer system structures were matched with federal grants. In fact, only part of the demand is eligible for grants.

Like all variables measuring desired levels, S^* is unobservable. It is eliminated from the equation to be estimated in a standard way: by incorporating partial adjustment. The assumption of partial adjustment in multiplicative (log-linear) form is

$$(3) \quad S/S_{-1} = (S^*/S_{-1})^\eta.$$

Combining (2) and (3) to eliminate S^* yields

$$(4) \quad M + \gamma G = \alpha^\eta H^{\beta\eta} (M + \gamma G)^{1-\eta}.$$

Equation (4) incorporates permanent displacement but not temporary displacement: the postponement of municipal construction either in the beginning or when major changes are made in the federal grants program. To measure temporary displacement, we enter as an explanatory variable the (real) budget authority for the program in each year less actual (real) outlays. This variable (A) should be large when the program really gets underway, but eventually should settle down to a steady state where, except for some years where major program changes occur, budget authority more or less equals outlays. Note that A is a flow rather than a stock since it represents a limited period of temporary confusion, and affects demand only during this period. Temporary displacement is added linearly so that an extra dollar will always have the same effect, regardless of the size of the unspent budget authority. This way of entering the variable is superior to the obvious alternative, to enter it multiplicatively. The multiplicative form would require that a doubling of this variable would always have the same percentage effect, whether the doubling is from a very small or very large base.

Adding temporary displacement and rearranging terms, we obtain the final form of the equation to be estimated:

$$(5) \quad M = \alpha^\eta H^{\beta\eta} (M + \gamma G)^{1-\eta} - \gamma G - \theta A.$$

II. Data

To measure the extent and timing of the local response to federal expenditure, we use

annual time-series data from 1949 to 1981. Time-series data are particularly useful here (as opposed to, say, a state cross section) because the program developed over time and changed sharply in some years.

The data series included the following: the stock of grants (where grants are measured as actual calendar year outlays of the Construction Grants Program), the stock of structures built with municipal funds (including a stock from expenditures necessary to match federal grants), and the residential housing stock. Each of the stocks of sewer system structures (federal and municipal) was composed of stocks of two components: sewer lines and treatment plants. All stocks were in 1972 dollars and were formed by the perpetual inventory method. Depreciation rates were 4 percent for lines, 10 percent for plants, and 2 percent for the residential housing stock. For plants and lines, depreciation rates are based on economic lifetimes provided by EPA. The spending series, which we cumulated into stocks for housing and sewer systems, were from U.S. Department of Commerce *Statistical Abstract*... (various issues) and *Value of New Construction*... (1975). Outlays and the budget authority of the Construction Grants Program were from U.S. Executive Office of the President, Office of Management and Budget (various issues) and the matching share and the spending on treatment plants and lines were from U.S. Executive Office of the President, Council on Environmental Quality (1976).

Since the construction of sewer systems began as far back as 1850, we began cumulating the stock then. Of course, most of this early stock had been depreciated by the beginning of the sample period. There was poor documentation of the split between plants and lines before 1965; we therefore treated all pre-1965 construction as lines.

III. Results of Estimation

Nonlinear least squares estimates of the demand for sewer system structures (equation (5)) are shown below. Estimates correcting for first-order serial correlation by means of a grid search were virtually identical.

Parameter	Estimate	t-value
$\alpha\eta$	.36	4.32
$\beta\eta$	.38	6.47
$1 - \eta$	.60	9.98
γ	.67	11.92
θ	.28	6.52

Range: 1949-81; R^2 : .998.

The coefficients of primary interest are those that measure permanent and temporary displacement (γ and θ). The estimate of .67 for γ , is strongly significant and is interpreted to mean that, for each dollar of federal expenditure, municipal expenditure is reduced by about two-thirds of \$1 and, further, that each dollar of federal expenditure is worth 67¢ to the community. Of course, the total gain from the expenditure, including the gain to those outside the community, could be much larger; a primary rationale for legislation requiring wastewater treatment is that municipalities disregard externalities from untreated wastewater.

In addition to the permanent displacement, we also found evidence for temporary displacement. We estimated that, for each extra \$1 of unspent budget authority, municipalities postpone about 28¢ of their expenditure. This temporary displacement is not trivial; the unspent budget authority was large at the beginning of the program.

The housing stock performs well as a scale variable.² Its coefficient is significant and the long-run coefficient turns out to be about .95 ($= \beta$), indicating that the dependence of the sewer system stock on the housing stock in the long run is almost exactly proportional.

IV. Further Results

To provide further information on the extent of displacement, we include several variations on equation (5) (see Table 1). The first variation (5a) replaces the variable A (tem-

²Because industrial activity can also generate water pollution, we tried as a scale variable a measure of the industrial capital stock added to the housing stock. We found, however, that the housing stock alone was superior.

TABLE 1 FURTHER RESULTS^a

Parameter	Equation		
	(5a)	(5b)	(5c)
$\alpha\eta$	.48 (5.15)	1.10 (2.56)	.67 (3.55)
$\beta\eta$	.32 (6.21)	.28 (4.02)	.36 (6.62)
$1 - \eta$	.65 (12.23)	.62 (7.48)	.56 (6.31)
γ	.62 (11.24)	.49 (5.20)	1.14 (8.46)
θ	1093.71 (7.32)	.22 (4.19)	.29 (4.23)
Range: 1949-81			
R^2	.999	.988	.996

^at-values are shown in parentheses.

porary displacement) with a simple dummy variable for 1972-74 to signify the beginning of the grants program.

The second variation (5b) changes the grant variable (G) from including only federal funds to including, as well, the local matching share. As a consequence, the discretionary stock now measures only the stock built with local funds other than those matching federal grants. This way of defining the M and G variables makes the entire cost of the project the source of displacement.

The third variation (5c) revises the measure of sewer system structures to include only sewer lines, not treatment plants. Of the two types of sewer system structures, treatment plants are more likely to generate benefits external to the community, and grants for treatment plants ought to involve less displacement than grants for lines.

In many ways, the variations confirm the qualitative results of the basic regression. Permanent displacement is always .5 or greater, and there is significant temporary displacement as well. Equation (5a), the dummy variable regression, shows almost the same permanent displacement as the basic regression. Equation (5b) has a smaller parameter for permanent displacement, but G is now correspondingly larger so that total (permanent) displacement is at least as large. Equation (5c), the equation for sewer lines only, shows displacement that is complete, which seems very reasonable since sewer lines

are valued primarily for their local services; there is little of the externality issue here.

V. The Effect of the Program on Expenditures

Although the theory and empirical results are provided in terms of stocks, the effect of the grants program on expenditure flows (such as current expenditure on sewer system construction) is perhaps of greater interest. Consider as an example the situation in 1973. In 1973, grants were \$1.05 billion and unspent budget authority (the source of temporary displacement) was \$5.03 billion. Because permanent displacement was about 67 percent (from equation (5)), \$714 million was permanently displaced (out of \$1.05 billion in total grants), leaving a net addition to total spending of \$346 million. Since the temporary displacement parameter was about 28 percent of the \$5.03 billion in budget authority less grants, \$1.4 billion was temporarily displaced. In that year, the net add-on to sewer system construction from the program was therefore about -\$1.06 billion. Since the total spending that was displaced (including both permanent and temporary) was about \$2.1 billion, and there were about \$1.05 billion in grants, total displacement in 1973 was about 200 percent.

The year 1973 was unusual because the large federal expenditure had just started. In a later year, say 1980, grants were \$3.93 billion, and unspent budget authority was -\$525 million. The net permanent displacement was \$2.67 billion, permanent add-on was \$1.26 billion, and temporary displacement was -\$147 million. Net additions to spending were therefore \$1.407 billion and total displacement was about 64 percent (\$2.523 billion as a proportion of \$3.93 billion). In addition, we would expect some catch up from the temporary displacement of past years via the partial adjustment process.

VI. Summary and Conclusions

Evidence from time-series data suggests that EPA grants for construction of sewer systems displace municipal expenditure for the same type of project. The displacement

involves temporary postponement of projects while grant applications are processed and permanent substitution of federal spending for what municipalities would have paid for themselves.

The finding of *temporary* displacement shows how grants may upset the spending plans of local government. Not only is there an administrative delay before expenditure can be made, but during the waiting period, municipalities may actually cut their own spending.

The finding of *permanent* displacement suggests that the grants do not increase the construction of sewer systems dollar for dollar; instead, state and local governmental units cut back their spending by about two-thirds.

That there is permanent displacement provides some evidence that the grants are valued by the recipients for the services they provide, not only for the income they bring to the region. To be more explicit, the findings do not accord with the usual assumption that the EPA is financing activities that the communities do not want. The way we are interpreting the parameters is standard. For example, Edward Gramlich and Harvey Galper (1978) interpret their parameters indicating displacement as a measure of how much federal grants contribute to the community's utility. In a different context, Timothy Smeeding (1977) uses displacement to measure the value to recipients of food stamps. As George Johnson and James Tomola (1977) point out, one likely objective of federal expenditures, even grants-in-aid, is pure revenue sharing, and this motive is best satisfied when there is 100 percent substitution of federal expenditures for state and local, that is, when grants have full value to recipients. Our evidence is that construction grants do have value to the recipients and, hence, have value as a program for partial revenue sharing.

Even so, the value of grants is eroded by the delay and by the administrative costs of preparing and evaluating grant proposals and of monitoring the grants. A question for future research is whether this erosion is offset by the efficiency gains of limiting externalities.

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